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Work-Centered Approach to Insurgency Campaign Analysis¹

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Abstract

This paper outlines the recent development of a prototype tool suite that implements a work-centered approach for insurgency campaign analysis. The analytical approach is built around the construction of a linked set of beliefs that form the work control structure of an insurgency movement and its operational campaign. The work control structure reflects a sensemaking model of how an organization such as an insurgency movement combines high level intent with work system capability to produce a stream of actions along various pathways of influence. The prototype tool suite enables the analyst to instantiate the set of beliefs with streams of observable events gleaned from intelligence reports and news reports. As these events are added to the model, the analyst uses them to adjust the evidentiary strengths of the belief elements and, ultimately, to identify emergent story lines that provide a plausible explanation of the insurgency movement's campaign strategy. The paper discusses how this approach offers advantages over existing methods of intelligence analysis. It then outlines the functional architecture of the tool suite and provides a brief hypothetical illustration of how it can be used to address the complexity of a modern insurgency movement.

Introduction: The Need for Insurgency Campaign Analysis

Considerable attention has been focused in recent years on developing methods and approaches for understanding the structure and operation of transnational insurgency movements. Interest in such tools generally stems from a desire to proactively detect and thwart the use of weapons of mass destruction against the United States by specific terrorist organizations. In a related area, interest also exists within the US military for tools that can assist operational planners in systematically understanding and targeting different types of insurgency groups operating within a specific combatant region. In response to such interest, the present paper explores a new approach to understanding transnational insurgency movements—an approach based on a fundamental analysis of the knowledge creation process inherently required by such movements for planning and successfully executing the accomplishment of their political intent. Labeled “campaign analysis,” this approach identifies the invariant aspects of this socio-cognitive process and uses them to frame the collection, interpretation, and integration of intelligence data into a predictive understanding of an insurgency movement as it operates to gain control within a specific country or region. By focusing at the fundamental level of knowledge creation, the resulting framework allows an understanding of insurgency movements to be constructed in a manner that is unencumbered by the constraints of western organizational thinking. The present paper presents a general outline of this new approach and illustrates how it could be translated into a collaborative tool for evidence management and predictive battlespace understanding.

Existing Analytical Approaches

A brief review of existing analytical approaches to understanding modern insurgency movements and terrorist operations reveals a number of significant shortcomings. Considered together, these shortcomings suggest the need for a deeper and more fundamental framework for constructing a predictive understanding of such movements.

Massive Data Collection with Automated/Aided Pattern Recognition

Automated pattern recognition approaches have been proposed for searching massive quantities of both open-source and classified intelligence data to reveal semantic relationships and patterns among key people, events, facilities, and other objects relevant to terrorist organizations and their operations. One such analytical effort was the

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Defense Advanced Research Project Agency's (DARPA) *Terrorism Information Awareness* (TIA) program², a project that was later cancelled by Congress due to a controversy regarding its alleged violation of US citizen privacy rights. Similar analytical approaches have been more recently undertaken within the intelligence community as part of the Advanced Research and Development Activity's (ARDA) *Novel Intelligence from Massive Data* (NIMD) program.³ More specifically, NIMD's *Glass Box* project focuses on tools for assisting intelligence analysts in the rapid exploitation of terabytes of open-source data. Functionalities being developed as part of the *Glass Box* project include automated data capture and time-stamping, analyst annotations, data review and filtering, plus an interface for sharing Glass Box data with other applications.⁴

At the heart of these initiatives is the assumption that such tools, when combined with the tacit expertise of intelligence analysts, will enable the discovery of objects and relationships relevant to constructing a real-time understanding of terrorist organizations and operations. While the value of advanced information management and collaborative work tools might be substantial, a basic shortcoming of these research initiatives is their *ab initio* nature that fails to benefit from any historical understanding of insurgency movements and terrorist operations. Thus, the resulting tool set affords no theoretical framework for organizing an analysis of available intelligence data. Rather, it presumes that meaningful frameworks will emerge through a serendipitous process of trial and discovery. Ironically, such an approach seems to reverse the thinking of the computer science community from years ago when it was presumed that machine processing could completely replace the need for human experts. The strategy taken now is one of providing a generic set of information mining and collaboration tools with the assumption that human expertise will guide or inform the interpretation and framing of available intelligence data into a cohesive understanding. While such an approach might prove productive with highly experienced intelligence analysts who have access to the computing power available within a national intelligence agency, it remains a question as to whether such an approach offers much help to the less-experienced military analyst or planner serving within a combatant theater of operations.

Statistical Analysis of Insurgency Trend Data

A second approach taken to understanding insurgency movements involves the statistical analysis of terrorism incidents and counterinsurgency trend data. An illustration of the first type of analysis can be seen in the annual report on incidents of terrorism published by the US National Counterterrorism Center⁵ and the corresponding US database on terrorist incidents maintained within the *Worldwide Incidents Tracking System*.⁶ Within this database, one can develop incident statistics organized by any number of factors such as geographic location, date, perpetrator characteristics, facility characteristics, damage level, and type of attack. Statistical analyses of counterinsurgency trend data typically broaden the types of information considered; however, the basic approach still involves summarizing different types of state variables over time. An example of this approach is seen in the Defense Department's annual report to Congress on stability and security operations in Iraq⁷ that provides a summary of various political, economic, and security indicators over a specific time period.

As noted by Richard Hayes *et al*, measuring terrorism is simple whereas measuring the progress of an insurgency movement is more complex.⁸ With an insurgency movement, there typically will be lots of relevant data available from various parties involved in the conflict –with each attempting to create a positive impression of their operational status and progress. There will also be many different interpretations of what this data means. Consequently, it is only when “*the issues are reduced to data and hypotheses are clearly formulated about the trends to be expected in the data can we hope to develop a realistic understanding of what is occurring.*”⁹ In short, the analysis of insurgency-relevant state variables must take place within a theoretical context in order for each element of the data to be properly interpreted and integrated into a holistic understanding. Simple trend summaries

² Defense Advanced Research Project Agency. (2003). *Report to Congress Regarding the Terrorism Information Awareness Program*. May 20, 2003.

³ Advanced Research and Development Activity (2005). “Novel Intelligence” webpage retrieved from http://www.ic-arda.org/Novel_Intelligence/ on 11 August, 2005.

⁴ Cowley, P.; Nowell, L.; & Scholtz, J. (2005). *Glass Box: An instrumented infrastructure for supporting human interaction with information*. *Hawaii International Conference on Systems Sciences*, Jan 3-6, 2005.

⁵ National Counterterrorism Center. (2005). *Report on Incidents of Terrorism 2005*. 11 April 2005.

⁶ The Worldwide Incidents Tracking System can be accessed and interactively searched at <http://wits.nctc.gov>.

⁷ Department of Defense. (2006). *Measuring Stability and Security in Iraq, Report to Congress*. August 2006.

⁸ Hayes, R.E.; Hayes, M.D.; Davis, B.C.; Keane, S.Y.; Kossakowski, P.; Leary, A.E.; Saenz, A. & Tarter, J.E. (2005). Measuring terrorism and insurgency in a 21st-century context. *Proceedings of the Cornwallis Group IX: Analysis for Stabilization and Counter-Terrorist Operations*, 5-8 April, 2004. Stad Shlaining, Austria. pp. 257-295.

⁹ Ibid.

and statistics, by themselves, will yield little predictive insight regarding the true status and progress of an insurgency movement.

Social Network Analysis of Terrorist Groups

A third approach to analyzing insurgency movements is reflected in various studies that have employed social network methods to identify relevant linkages among participants in such a movement. The method—related to network theory—attempts to mathematically construct a network of nodes and ties that link individuals and organizations in socially meaningful ways. Social network analysis is based on several premises: (1) social networks operate on many different levels; (2) they play a critical role problem-solving; and, hence, (3) they provide insight into how organizations achieve their goals. For example, social network analysis has been used to reconstruct the terrorist network involved in the 9/11 attacks on New York and Washington, DC.¹⁰ Using this method to analyze available data regarding e-mail/telephone contacts, face-to-face meetings, and funding channels, it was shown that each of the 19 hijackers involved in this orchestrated attack were socially linked within two steps of the two original suspects—Nawaf Alhazmi and Khalid Almihdhar—uncovered prior to the attack in 2000. This same study also revealed that Mohammed Atta was a local leader of this al-Qaeda cell.

The use of social network analysis would appear to be a natural fit with insurgency movements. Kathleen Carley, for example, claims that social network analysis can be used to identify both the structural classification and critical nodes associated with a specific terrorist network.¹¹ The argument follows that this knowledge can be used to attack and disrupt information flow and decision making within a network—thus destabilizing its operation and diminishing its effectiveness. In a later study, Carley claims an even more powerful approach—dynamic network analysis—for studying terrorist networks through the use of agent-based modeling.¹² However, as noted by John Robb, evidence indicates that insurgency networks aren't susceptible to disruption in a traditional organization sense.¹³ Such networks tend to exhibit certain properties that violate the assumptions of social network theory. First, they are redundant in terms of leadership. Emergent leaders quickly ascend when other leaders are removed, often through pre-existing, latent connections that are “turned on” as needed. Second, they are composed of a meta-matrix of networks for information transfer, knowledge sharing, task completion, and so forth. Third, they are dynamic in nature. Relationships within an insurgency network are not dictated by a assigned hierarchical relationships. Rather they are “*based on a panoply of factors that are constantly changing. Therefore, the structure of the network is in constant flux in response to learning and adaptation by the individual nodes.*”¹⁴

The shortcomings of social network analysis as a method for studying insurgency movements reflect an underlying philosophical disconnect. Social network analysis emphasizes organizational structure over organizational purpose and functioning. That is, as a methodology, it begins with the study of organizational structure and presumes that an understanding of purpose and functioning can be derived from an identified structure. Insurgency movements, however, begin with a purpose and establish an adaptive functioning over time to accomplish that purpose. As noted by Robb, the organizational structure of an insurgency movement can contain latent elements, emergent leadership, and adaptive task definition—all of which constantly evolve over time to accommodate the conditions within which the movement must operate. Thus, in order to properly study an insurgency movement, one must begin with an understanding of purpose and functioning and, only then, move toward the inference and verification of organizational structure.

Focused Analysis of Insurgency Characteristics

A fourth approach identified in the literature on insurgency analysis can be described as a collection of analyses that focus on selected aspects of an insurgency movement. These studies address a range of topics and employ a variety of analytical and qualitative research methods. Their common feature is simply that they serve to provide deeper insight into a particular facet or characteristic of insurgency movements. For example, one study has compared terrorist cells with organized crime rings in an attempt to determine the optimal effective group size

¹⁰ Krebs, V.E. (2002). Mapping networks of terrorist cells. *Connections*, Volume 24(3). pp. 43-52. [retrieved from <http://www.insna.org/Connections-Web/Volume24-3/Valdis.Krebs.web.pdf> on 28 September, 2006.]

¹¹ Carley, K.M.; Lee, J. & Krackhardt, D. (2002). Destabilizing networks. *Connections*, Volume 24(3). pp. 79-92.

¹² Carley, K.M.; Dombroski, M.; Tsvetovat, M.; Reminga, J. & Kamneva, N. (2003). Destabilizing dynamic covert networks. *Proceedings of the 8th International Command and Control Research and Technology Symposium*, Washington, DC. Vienna, VA: Evidence Based Research. Inc.

¹³ Robb, J. (2004). Destabilizing terrorist networks. *Global Guerrillas*, 22 March, 2004. [Weblog entry retrieved from <http://globalguerrillas.typepad.com> on 24 September, 2006]

¹⁴ Ibid.

(thought to be between five and twelve members).¹⁵ In a study of suicide terrorism, Robert Pape found that recent increases in the incidence of suicide attacks can be explained as a logical lesson learned from past insurgency movements.¹⁶ Quite simply, suicide attacks were found to be effective in coercing target nations such as Lebanon, Israel, and Sri Lanka to cede territorial control to different insurgency movements. In another study that examined the socio-psychological profiles of modern terrorists, Rex Hudson found that there exists an increasing willingness of religious fundamentalist groups to employ weapons of mass destruction to achieve their goals.¹⁷ In addition, this same work identified specific psychological types who would be most likely to use or threaten the use of weapons of mass destruction. At the same time, there is an increasing tendency of these groups to recruit highly trained individuals from the fields of communications, computer programming, engineering, finance, and the sciences. Whereas the elite terrorist commandos of the 1960s and 1970s were limited to what they learned in training camps, the recruitment of individuals who reflect both religious zealotry and technical expertise increases the likelihood of highly skilled and orchestrated attacks in the future. In a more recent study of the psychology of terrorism, Jeff Victoroff notes that much of the published work in this area is theoretical—rather than empirical—in nature.¹⁸ Thus, much of our understanding of the mind of the terrorist is likely to be based on flawed premises. In response, he argues that our study and analysis of insurgency movements must balance both theory and evidence—or more specifically, that “*the best solution is hypothesis-based research and evidence-based policies.*”¹⁹

While a review of these types of focused studies suggests their potential utility for understanding the nature and behavior of different insurgency movements, they do not provide a holistic framework for predictive analysis. As noted earlier in this paper, insurgency movements are dynamically shaped by a panoply of factors. Thus, while these analyses might offer insight into a specific aspect of their operation, it is only when they are considered in the context of other factors that one can begin to construct a realistic understanding of an insurgency movement.

Formal Modeling of Insurgency Movements

A final approach identified in the literature on insurgency analysis involves the formal modeling of insurgent group behavior and decision making. The term “modeling” covers a wide range of analytical approaches; however, the efforts addressed here each have the common goal of predicting the behavior of specific insurgency movements. In one study by Ransom Weaver *et al.*, the authors illustrate a decision-theoretic approach to modeling different levels of a decision cycle within a terrorist organization—*e.g.*, create an organization, plan a campaign, select specific missions, plan a mission, and conduct operations.²⁰ Assuming a “rational actor” model of decision making, they illustrate various approaches—*e.g.*, Markov chains, game theory—for modeling course-of-action decision choices by terrorist groups. In another study, Jim Doran constructs an agent-based model of guerrilla warfare to analytically explore the effectiveness of specific insurgency tactics.²¹ As a potential tool for guiding cease-fire negotiations, the resulting model offers predictive insight into such tactics as an all-out counterinsurgency campaign by government forces (*e.g.*, the so-called “Salvador option”) or a hyper-mobile strategy by insurgents (*e.g.*, the use of “flying columns” by the Irish Republican Army). In another agent-based modeling study, Michael Findley and Joseph Young delve deeper into various factors characterizing a population’s attitudes toward an insurgency.²² Here, they are able to analytically explore the interaction of (1) attrition policies that impose costs of supporting an insurgency on a population with (2) “winning hearts and minds” policies that provide benefits to the population. A systems dynamics model of insurgency movements has been developed by Edward Anderson to explore the interaction of various relevant causal loops such as an “insurgency suppression” loop, an “insurgency creation” loop, a “foreign war effect” loop, and a “population war weariness” loop.²³ Testing the model against the *Anglo-Irish War*

¹⁵ Robb, J. (2004). The optimal size of a terrorist network. Global Guerrillas, 24 March 2004. [Weblog entry retrieved from <http://globalguerrillas.typepad.com> on 24 September, 2006]

¹⁶ Pape, R.A. (2005). *Dying to Win: The Strategic Logic of Suicide Terrorism*. New York: Random House.

¹⁷ Hudson, R.A. (1999). *The Sociology and Psychology of Terrorism: Who Becomes a Terrorist and Why?* Washington, DC: Federal Research Division, Library of Congress.

¹⁸ Victoroff, J. (2005). The mind of the terrorist. *Journal of Conflict Resolution*. Volume 49, Number 1. pp. 3-42.

¹⁹ Ibid.

²⁰ Weaver, R.; Silverman, B.G.; Shin, H. & Dubois, R. (2001). Modeling and simulating terrorist decision-making: A “performance moderator function” approach to generating virtual opponents. *10th Computer Generated Forces Proceedings*, New York: SISO & IEEE. May, 2001.

²¹ Doran, J. (2006). Modelling a typical guerrilla war. *Proceedings of the IEEE Workshop on Distributed Intelligent Systems: Collective Intelligence and Its Applications (DIS’06)*, 15-16 June, 2006. Prague, Czech Republic.

²² Findley, M.G. & Young, J.K. (2006). *Swatting Flies With Pile Drivers? Modeling Insurgency and Counterinsurgency*. Working paper retrieved from <http://garnet.acns.fsu.edu/~jky04/swattingflies.pdf> on 29 Sept 06.

²³ Anderson, E.G. (2006). A preliminary system dynamics model of insurgency management: The Anglo-Irish war of 1916-21 as a case study. *The 24th International Conference of the System Dynamics Society*, 23-27 July, 2006. Nijmegen, The Netherlands.

of 1916-21 case study, the author found that no single parameter or variable is likely to offer a sufficient mechanism for controlling an insurgency movement. Rather, control of an insurgency movement requires “policies that create many simultaneous, synergistic changes.” Results from the same model also suggest that it might very well be impossible to completely eliminate an insurgent activity. Rather, even the best combination of actions will merely reduce it to an acceptable level.²⁴

More general writings on the modeling of insurgency movements can also be found in the current literature. These papers offer insight into the proper framing of analytical issues, but have not yet transformed these ideas into a specific computational model. For example, several papers by Thomas Hammes have provided a framework for understanding the political underpinnings and evolving tactics employed by insurgency movements over the past several decades.^{25,26} Insurgency movements are characterized as “fourth generation warfare,” in contrast to previous generational models of military conflict.²⁷ Tracing the evolution of insurgency movements from Mao Tse-Tung to Afghanistan and Iraq, Hammes concludes that insurgency movements often involve a loose coalition of the willing on the anti-government side who are prepared to employ a variety of low-intensity military, economic, social, and information methods and networks to (1) shape what a society thinks about itself and the world and (2) influence the minds of government policy makers. Insurgency campaigns are waged at several levels—national, international, transnational, and subnational—over time to achieve the long-range goals of change. In response, we must develop more agile and comprehensive ways of dealing with insurgency movements rather than assuming that they can be forced into a conventional type of high-technology, maneuver warfare. As noted by Hammes, “*Rather than seeking better ways to fight the conventional wars we already dominate, we must find better ways to fight the kinds of wars we lose — fourth-generation wars.*”²⁸

In another paper that explores recent counterinsurgency operations in the Republic of the Philippines and Operation Iraqi Freedom II, Eric Wendt more formally introduces a number of theoretical models that can be used to guide strategic planning.²⁹ An “area of influence” model focuses attention on the fundamental issue of moving a population’s support away from an insurgency movement and toward the government through a mixture of “stick and carrot” methods. An “insurgency support and flow” model identifies key elements of a region’s infrastructure supporting an insurgency movement. This model recognizes the principle that there typically exist ten sympathizers within a civilian population for every member of an insurgency movement. An “equivalent response” model identifies the narrow band of effective response options that can be taken against an insurgency movement. Too much proportionate violence or control only serves to alienate the population, whereas too little violence or control leads to the impression that the government is powerless or ineffectual. A “diamond insurgent / counterinsurgent model” model illustrates the various lines of operation competitively used by the government and insurgency movement to influence the internal population and international actors. A final “military component” model illustrates the coordinated use of constabulary forces, quick reaction infantry forces, and maneuver-to-contact forces for isolating and defeating the military elements of an insurgency movement.

The theoretical frameworks—or models—offered by Hammes and Wendt are not yet in an analytic form that can assist in the detailed analysis and assessment of a specific insurgency movement. Yet, they each provide useful ways of thinking about the essential elements of an insurgency movement. Like any good theoretical model, they serve to focus attention on what is important or critical to our understanding of a problem. As such, they provide guidance for developing future tools that can help intelligence analysts and military planners in identifying, isolating, interpreting, and targeting the critical elements of an insurgency movement.

Deficiencies of Existing Approaches

A review of existing analytical approaches to understanding the nature and status of an insurgency movement reveals a number of deficiencies. For example, automated search algorithms for mining massive quantities of open source literature rely upon the tacit expertise of the analyst to frame or guide what is otherwise a serendipitous process of trial and discovery of relevant knowledge elements. Statistical analysis of insurgency-relevant state variables focuses on past or current events that, without placement within the context of informed hypotheses, are

²⁴ Ibid.

²⁵ Hammes, T.X. (1994). The evolution of war: The fourth generation. *Marine Corps Gazette*, September 1994. pp. 35-44.

²⁶ Hammes, T.X. (2004). 4th-generation warfare: Our enemies play to their strengths. *Armed Forces Journal*, November, 2004. pp. 40-44.

²⁷ The first generation of modern war was dominated by massed manpower and culminated in the Napoleonic Wars. The second generation was dominated by firepower and ended in World War I. During World War II, the Germans introduced third-generation warfare, characterized by maneuver. That type of combat is still largely the focus of U.S. military forces.

²⁸ Ibid.

²⁹ Wendt, E.P. (2005). Strategic counterinsurgency modeling. *Special Warfare*, September, 2005. p. 2-13.

unlikely to yield predictive insight. Social network analysis, which attempts to model a fixed organizational structure rather than focusing on purpose and functioning, fails to address the dynamic and emergent nature of insurgency movements. Studies that focus on a specific aspect of an insurgency movement—e.g., their recruitment of specific types of individuals—offer limited insight, but they do not provide a holistic framework for predictive analysis. Finally, a number of theoretical modeling efforts offer a useful framing of issues; however, these frameworks require additional development in order to be useful as an analytical tool.

At a more fundamental level, existing methods of analysis fail in two respects. First, as suggested in the preceding paragraph, they fail to incorporate strategic thinking into their analytical framework. Searching for surface-level bits and pieces of an insurgency movement places focus on their immediate tactical details while ignoring the grand strategy inherent in most insurgency campaigns. Counterinsurgency operations based on such intelligence analysis is thus likely to reflect a “whack-a-mole” policy of responding to individual attacks and localized combat initiatives while failing to deal with the more fundamental aspects of a long-term insurgency campaign. Second, such methods of intelligence analysis are not integrated with the operational planning process that ultimately uses their products and findings. As noted by the Air Force Scientific Advisory Board in a 2002 assessment, predictive battlespace awareness (PBA) requires a cultural change that will enable air and space commanders to anticipate, pre-empt, influence, and decisively defeat their adversaries. Specifically, “PBA is not an intelligence product or service that is handed to the commander. Rather, PBA is a commander-driven, pre-crisis predictive process that must transition seamlessly from the strategic, to the operational, to the tactical level of war.”³⁰ More recently, Piccerillo and Brumbaugh have noted that traditional intelligence assets and processes are not postured to effectively support effects based operations.³¹ Specifically citing experience in Afghanistan and Iraq, they argue that reconnaissance, surveillance, and intelligence operations should be employed for confirmation rather than discovery type missions—i.e., missions based on an anticipatory understanding of an insurgency’s campaign plan. It follows that an operational planning framework provides an appropriate structure for building an understanding of an insurgency movement—one that specifically addresses the components of an insurgency campaign and how the Joint force commander’s counterinsurgency operations can be tailored to defeat this campaign. Here, existing military doctrine provides a number of frameworks—most notably, the “elements of operational design”—that can be applied in reverse to the analysis of an insurgency campaign in order to identify critical elements and their referent linkages within an overall understanding.

A Work-Centered Approach

To remedy these deficiencies, Evidence Based Research, Inc. (EBR) has undertaken the prototype development of an analytical tool suite that reflects a work-centered approach to understanding the nature and status of an insurgency movement. Initiated with funding support and technical guidance from the US Air Force Research Laboratory’s Human Effectiveness Directorate, this approach is based on the concept of developing and organizing this understanding within the framework of an insurgency movement’s work control structure. In this regard, the approach draws heavily upon past research that addresses how organizations (such as an insurgency movement) link high-level intent with tactical level action through the development of a work control structure. This understanding is augmented by military planning doctrine that historically identifies the nature and structure of a military campaign. Together, these understandings guide the development of an epistemological framework for assembling and interpreting available intelligence information into a cohesive picture of an insurgency campaign—one that can be used to guide Joint military planners in identifying appropriate targets and actions to defeat an insurgency movement. As such, this framework is specifically matched with the natural tendency of human analysts and decision makers to (1) mentally shape their understanding of an operational situation in story form and (2) instantiate that understanding to a workable level of certainty on the basis of available observations.

Analytic Strategy

The work-centered campaign analysis approach responds to two basic needs of the analyst who is faced with multiple streams of insurgency-related events within a theater of operation: (1) reduce order (ambiguity and equivocality) to provide a coherent explanation of a complex and evolving situation and (2) instantiate beliefs to a workable level of certainty. Accordingly, the analytic strategy provides the following functionality:

³⁰ US Air Force Scientific Advisory Board. (2002). *Report on Predictive Battlespace Awareness to Improve Military Effectiveness, Volume 1: Summary*, SAB-TR-02-01. July 2002. p. vi.

³¹ Piccerillo, R.A. & Brumbaugh, D.A. (2004). Predictive battlespace awareness: Linking intelligence, surveillance, and reconnaissance operations to effects based operations. *2004 Command and Control Research and Technology Symposium*, San Diego, CA, 15-17 June, 2004.

- *Incrementally build understanding in a “top down” and “bottom up” manner simultaneously*, so as to construct and maintain a feasible story regarding an insurgency campaign’s lines of operation and tactical actions;
- *Stories are epistemologically framed by a work control structure* that coherently connects an insurgency’s intent with its capabilities and provides a cause/effect context for explaining observed and predicted events and conditions;
- *Incorporate multiple perspectives*, so as to appreciate the breadth and complexity of the operational and tactical problem space impacted by the insurgency campaign;
- *Construct situational meaning* of observed events and conditions as a function of their *negotiated placement within an overall story* –i.e., understanding is autopoietic in nature; and
- *Treat beliefs as nonpersistent, situation-dependent propositions*, not static, universal truths –i.e., beliefs will change in relation to the emergent and opportunistic strategies and tactics of the insurgency movement

In order to implement this strategy, we adopt a constructivist or sensemaking philosophy by defining data, information, situation awareness, and situation understanding in the following manner:

- *Data* – a collection of numbers, words, images, or other symbols that symbolically represent bracketed artifacts of a situation. Bracketed artifacts reflect observed facts or abstracted assertions that are singled out for attention based on their perceived relevance to a work system’s constructed problem space.
- *Information* – a collection of bracketed artifacts that specifically reduce uncertainty in a holistic framework of situation awareness and understanding of a work system’s constructed problem space.
- *Situation Awareness* – the bracketing of specific artifacts within an operational environment, based on their relevance to a work system’s constructed problem space.
- *Situation Understanding* – the functional association of these bracketed artifacts in a way that links intent with capability to give meaning to effects and actions within a work system’s constructed problem space.

Together, these epistemological elements form a self-referent and holistic picture of an insurgence campaign as it evolves over time.

Work Control Structure: A Framework of Instantiated Beliefs

The analysis of an insurgency campaign is framed by an epistemological structure we call a “*Work Control Structure*,” an analytical construct that reflects an extension of earlier work by Jens Rasmussen³² and its consistent with the data/frame model of sensemaking proposed by Gary Klein³³. A work control structure reflects an organization’s open-ended referent knowledge structure for linking intent with action and accomplishing purposeful work. It provides a socio-cognitive framework within which to organize available information, tacit expertise, and organizational recipes in a relevant manner, to develop both awareness and understanding of the operational environment, and to plan and execute goal-related actions that move the organization toward a desired endstate. A work control structure can be seen as an achieved state of knowledge that is constructed, negotiated, and dynamically maintained by many different people working together throughout the organization. Typically, no individual has complete knowledge of and control over an organization’s work control structure in its entirety. Rather, different individuals and communities of interest collaborate to integrate the levels of thinking illustrated in Figure 1.

Normally, an organization develops and maintains its work control structure over time through its planning and execution process. In the current project, we apply the concept of a work control structure in a reverse engineering manner, based on intelligence analyses and a stream of on-going behavioral observations from the theater of operation. For example, the top four levels of the work control structure for an insurgency campaign under study can be developed from regional studies and assessments. Similarly, the bottom level (work system capabilities) can be developed from these same documents. However, the elements comprising these levels represent a more abstract understanding of an insurgency campaign –i.e., they represent a linked set of working hypotheses that, over time, will evolve according to the adaptive nature of insurgency movements. Thus, these beliefs must be instantiated

³² Rasmussen, J.; Pejtersen, A.M. and Schmidt, K. (1990). *Taxonomy for Cognitive Work Analysis*. Roskilde, Denmark: Risø National Laboratory.

³³ Klein, G.; Phillips, J.K.; Rall, E.L. & Peluso, D.A. (2007). A data/frame theory of sensemaking. In R.R. Hoffman (ed.) *Expertise Out of Context: Proceedings of the 6th International Conference on Naturalistic Decision Making*. Mahwah, NJ: Erlbaum.

(given evidentiary support) through the analysis of on-going events and actions observed to be taken by the insurgency movement.

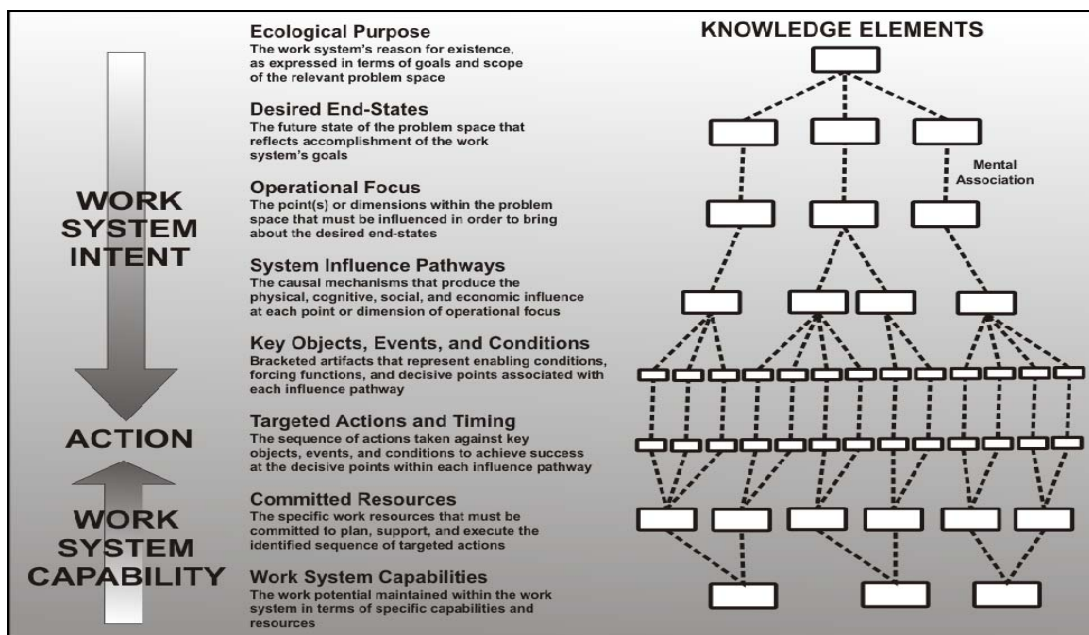


Figure 1 Work Control Structure

The middle three levels of the work control structure (key objects/events/conditions, targeted actions and timing, and committed resources) represent the more concrete and observable elements of an insurgency campaign. Unlike the more abstract levels within the work control structure, these levels can be directly instantiated through behavioral observations from the theater of operation. As intelligence reports and open-source news items are received, they can be gleaned to document specific instances where the insurgency movement has committed resources to execute an action against a key object (*e.g.*, political figure, neighborhood, military unit, facility), event (*e.g.*, street protest, parliamentary election, government operation), or condition (*e.g.*, political unrest, disenfranchised population). As these behavioral observations are accumulated, they can be functionally associated upward with specific system influence pathway hypotheses and used to provide either supportive or contradictory evidence for these hypotheses. Computationally, Bayesian analysis can be employed to provide continual updating of an "evidentiary strength" for each system influence pathway hypothesis, based on an incoming stream of behavioral observations. Through a system of analyst-assigned weighting factors, evidentiary strengths can be propagated upward from system influence pathways to compute a belief strength for each operational focus. Likewise, these same observations can be organizationally associated downward with hypothesized work system capabilities to instantiate the relative power and influence of different parts of the insurgency movement's organization.

Story Lines: A Natural Framework for Framing Understanding

Over time, as the analyst builds and maintains this linked set of hypotheses and behavioral observations, story lines begin to emerge that provide high levels planners and decision makers with a more holistic picture of an insurgency campaign. As seen in Figure 2, a story line reflects a linked set of instantiated beliefs that combine intent with capability to explain a specific set of observations over time. Thus, a completed story line represents a vertical set of associations that (1) extend from the operational focus and desired endstates of an insurgency campaign, (2) continue downward through an instantiating set of behavioral observations (key objects, targeted actions, committed resources), and (3) connect with work capabilities reflected in the current organizational structure of the insurgency movement. Once developed, each story line can be used to

- Identify areas of ambiguity and uncertainty that drive future intelligence collection,
- Assess the relative progress of an insurgency campaign along a specific line of operation, and

- Predict future actions that an insurgency movement might take to further its progress along a specific line of operation.

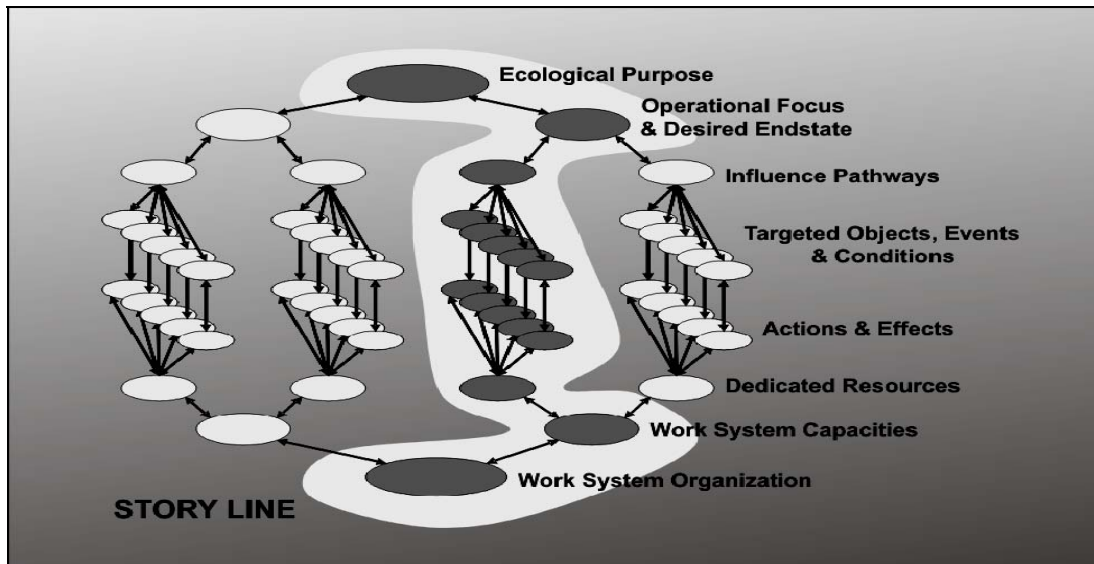


Figure 2 Emergence of Story Line within a Work Control Structure

Implementing Architecture

The software architecture currently implementing a prototype of this approach is organized around five functional modules that operate against an analytic backplane. Each of the five modules reflects a specific step in the analyst's sensemaking process, while the analytic backplane maintains a current state of the belief structure emerging from these processes. As shown in Figure 3, the modules can be employed in an iterative sequence as the analysts move back and forth between maintaining a set of hypothesized beliefs and instantiating these beliefs with real-world observations. Depending upon the specific nature of the insurgency campaign and the availability of supporting intelligence, story lines can emerge in either a top-down or bottom-up fashion since the work control structure represents a self-referent epistemological framework. The flexibility of this approach corresponds to the natural sensemaking strategies of human decision makers. At the same time, it avoids the computational pitfalls associated with knowledge management projects that reflect more of a logical positivist approach –i.e., fixed ontologies of meaning, rigid propositional logic.

Analytic Backplane

The analytic backplane maintains the current state of a hierarchically linked belief elements that allow the analyst to build a story-like understanding of the insurgency campaign. The data elements comprising this backplane tie together the different analyst modules incorporated into the analysis tool.

Module 1 – Build High-Level Intentionality Beliefs

Module 1 allows the analyst to construct and maintain the top three levels of the work structure. The analyst populates belief elements to the backplane via a dialog window that opens within a graphical database manager. The graphical database manager then allows the analyst to view a graphical map of the resulting network of beliefs. As beliefs are added to the structure, they are hyperlinked to supporting intelligence data, regional analyses, and historical analogies.

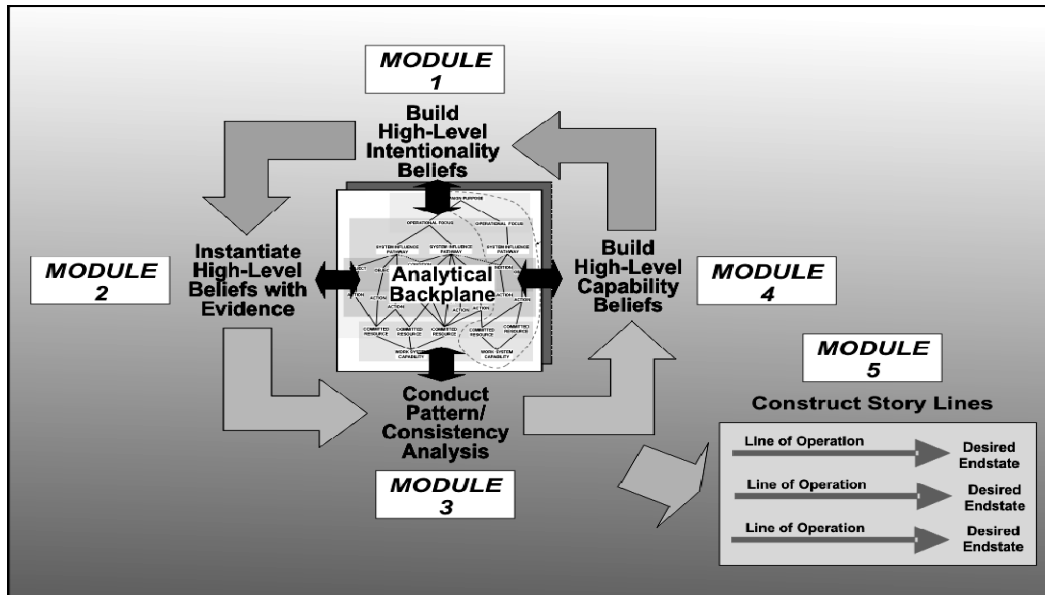


Figure 3 Insurgency Campaign Analysis Tool Architecture

Module 2 – Instantiate High-Level Beliefs with Evidence

Module 2 enables the analyst to perform each of two analytical tasks. The first task allows the analyst to enter a stream of intelligence reports in the form of triads that each include a key object/event/condition uniquely paired with an action and a committed resource. This task also allows the analyst to modify existing triads. As “object/action/resource” triads are constructed, they are hyperlinked to reference documents that contain supporting intelligence data –e.g., news reports, speeches, informant interviews. The second task allows the analyst to specify a set of triads to be associated with each influence pathway. The analyst specifies an evidence ratio and a contribution weight for each triad as it is associated with a specific influence pathway. The resulting evidence strengths for each pathway are then computed by applying the Bayesian formula to its associated set of triads. Current evidence strengths are posted to the graphical database display.

Module 3 – Conduct Pattern / Consistency Analysis

Module 3 enables the analyst to perform each of several analytical tasks. The first task allows the analyst view the resulting belief strengths for the framework of high-level intentionality beliefs in levels 1-3 of the work control structure. Belief strengths for each of the operational foci are computed using a weighted Euclidean distance formula applied to its children elements. The second task allows the analyst to conduct a pair-wise morphological analysis on the constructed set of triads to indicate where the insurgency has shifted tactics. The third task allows the analyst to develop and interpret a multidimensional scaling solution for the set of triads –i.e., clustered triads enable dynamic redefinition of system influence pathways.

Module 4 – Build High-Level Capability Beliefs

Module 4 enables the analyst to construct and maintain level 8 of the work control structure. In the first task, the analyst adds belief elements to the backplane via a dialog window. The analyst uses graphical database manager to graphically view the current state of the structure. Work system capabilities in level 8 are hypothesized on the basis of historical principles of insurgency and regional analysis. As belief elements (work system capabilities) are constructed, they are hyperlinked to reference documents that contain supporting intelligence data, regional analysis, and historical analogies. Module 4 also allows the analyst to develop and interpret a second type of multidimensional scaling solution for the set of triads –i.e., clustered triads enable identification of underlying work system capabilities. The analyst can then populate the work control structure with these identified work system capabilities.

Module 5 – Construct Story Lines

As the four analytical modules are iteratively applied to build the work control structure, the analyst is able to see story lines emerging from the graphical structure displayed by the graphical database manager. Story lines represent a vertical set of belief element associations that link intent and capability to explain and predict a pattern of purposeful behavior. As shown in Figure 4, story lines are constructed around hypothesized lines of operation. Triads are graphically displayed along a temporal scale and compared with key progress milestones to define the history and current state of the insurgency campaign.

Prototype Implementation

A fully functional proof-of-principle prototype has been implemented using commercial off-the-shelf software. Mindjet *MindManager*® Version 6 provides the graphical database management and visualization capability, with the computational aspects of the tool executed in Microsoft *Excel*® and SPSS for Windows. An extensive array of Visual Basic add-ins provide for user dialog windows and integration of the various software packages. The entire tool suite runs on a standard desktop computer running the Windows XP operating system.

Brief Illustration

Discussion of the project's actual case study undertaken with a real-world insurgency movement is beyond the scope and level of detail of this paper. Instead, the following hypothetical example briefly illustrates the potential complexity that can be handled by the campaign analysis tool. In this example, the XYZ Insurgency Movement represents a religious minority group that is attempting to gain political power and transform a pro-Western country into a theocratic republic. The movement draws its support from three sources: (1) the religious minority population within the country, (2) a neighboring republic that is sympathetic to overthrowing the country's existing pro-Western government, and (3) a scattered diaspora of the minority population located in various communities around the world. As seen in Figure 4, the movement has developed a long-term insurgency campaign around three desired end states: (1) the removal of Western imperialism from the country, (2) the replacement of the existing pro-Western government with a theocratic republic, and (3) the recognition and acceptance of the movement as a legitimate representative of the civilian population within the country. Reflected in these desired endstates are three corresponding centers of gravity or points of operation focus around which its campaign is hypothesized to be organized.

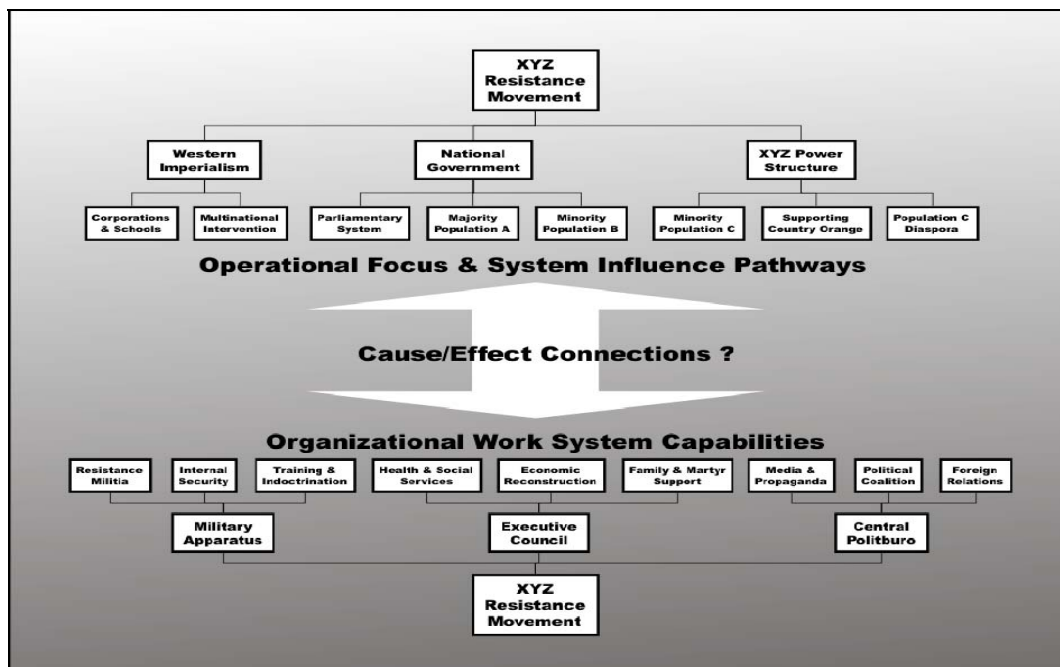


Figure 4 Fictional Insurgency Campaign: High-Level Intent and Work System Capabilities

From historical analyses of the region and comparison of the XYZ Resistance Movement with past insurgency movements, it is further hypothesized that its campaign is attempting to gain progress through the eight system influence pathways shown in Figure 4. Each pathway is described in terms of a desired effect to be achieved by the resistance movement and a targeted set of obstacles and opportunities:

- *Western Corporations and Schools*: Removal of Western-owned business corporations that are monopolizing the country's economy and Western-sponsored institutions of higher learning that are fostering an anti-religious secular culture within the country.
- *Multinational Intervention*: Persuasion of the United Nations Security Council that military intervention within the country by a coalition of Western nations is unnecessary to bring order and stability to the country.
- *Parliamentary System*: Political domination of the country's parliamentary form of government that results in the resignation of the existing pro-Western prime minister and the replacement of this government with a radical coalition led by the XYZ Resistance Movement.
- *Majority Population A*: Political co-option of the country's secular majority population that results in its acceptance of the XYZ Resistance Movement's radical coalition as being in the best interests of national sovereignty.
- *Minority Population B*: Political co-option of the country's other religious minority population that results in its acceptance of the XYZ Resistance Movement as a legitimate representative of its economic and social interests.
- *Minority Population C*: Development of strong support for the XYZ Resistance Movement as its ethnic identity and leader, including continued financial support and recruitment of resistance members from this population.
- *Supporting Country Orange*: Continued economic and military weapons support for the XYZ Resistance Movement, and endorsement of the XYZ Resistance Movement as an essential partner in a broader struggle to develop a pan-theocratic region in this part of the world.
- *Population C Diaspora*: Continued economic and political support for the XYZ Resistance Movement's health, social services, and reconstruction initiatives through an international network of charitable organizations and business cartels.

Shown at the bottom of Figure 4 are a set of work system capabilities hypothesized to correspond to the current (but evolving) organizational structure of the XYZ Resistance Movement. Like the pathways of influence, these capabilities would be derived from current intelligence summaries. They include

- *Resistance Militia*: The conventional army wing of the XYZ Resistance Movement comprised of basic recruits and technical specialists that defend Minority Population C neighborhoods and carry out actions designed to intimidate key elements of the existing government and pro-Western interests within the country.
- *Internal Security*: The highly covert special forces wing of the XYZ Resistance Movement, comprised of loyal followers, that maintains internal discipline and organizes political protest events.
- *Training and Indoctrination*: A special unit attached to the militia that transforms civilian recruits into various military specialists and provides political indoctrination into the movement's system of religious discipline.
- *Health and Social Services*: A publicly visible element of the XYZ Resistance Movement that provides community health care and medical services to neighborhoods primarily indwelt by Minority Population C, but extending to include Minority Population B (takes the place of services that cannot be provided by the existing government).
- *Economic Reconstruction*: A publicly visible element of the XYZ Resistance Movement that provides economic reconstruction and vocational training for Minority Population C neighborhoods.
- *Family and Martyr Support*: A publicly visible element of the XYZ Resistance Movement that provides economic support the widows and children of martyrs who have died in suicide attacks executed on behalf of the resistance movement.

- *Media and Propaganda*: A network of TV, radio, and news service organizations that provide coverage of on-going events and conditions within the country from the political perspective of the XYZ Resistance Movement.
- *Political Coalition*: A political alliance comprised of the XYZ Resistance Movement and other minority political parties that back a list of parliamentary seat holders and push for the reformation and/or resignation of the existing pro-Western government.
- *Foreign Relations*: The XYZ Resistance Movement's formal relations with sympathetic nations that provide a degree of legitimacy and acceptance of the movement within the world's diplomatic community.

The upper and lower levels of belief elements within the work control structure represent a set of hypotheses that must be instantiated and given evidentiary support through concrete events. Thus, the challenge illustrated in the middle of Figure 4 is for the analyst to identify and develop cause-effect connections that link the set of work system capabilities to the set of system influence pathways. As these connections are formed and strengthened, story lines begin to emerge as explanations and progress assessments of the overall insurgency campaign.

Shown in Figure 5 are several event observations that might be gleaned from streams of on-going intelligence reports and news reports. While the number of such events would likely be very high with an active insurgency campaign, we illustrate only a few here to show how they can be used to instantiate the hypothesized work control structure.

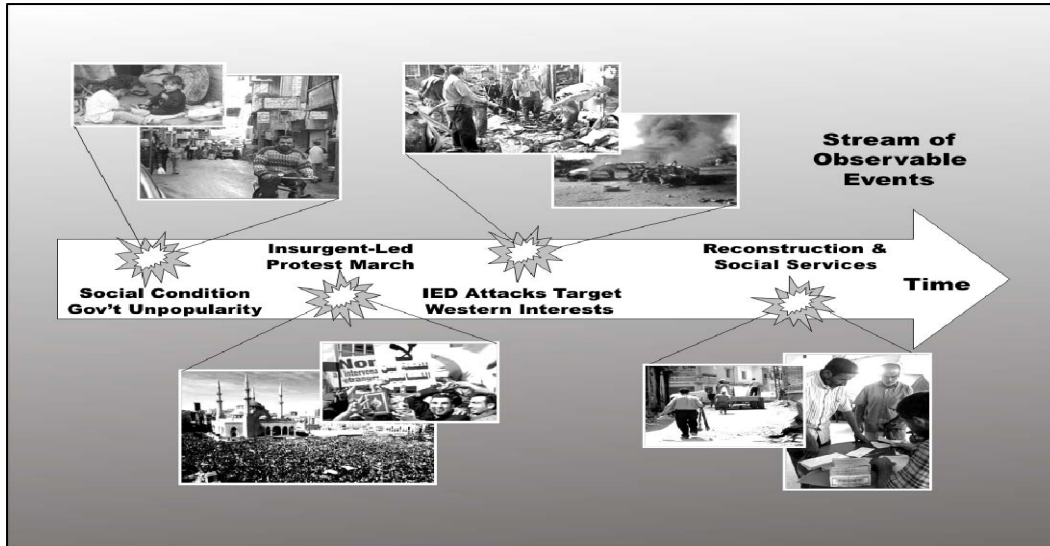


Figure 5 Fictional Insurgency Campaign: Stream of Observable Events

Considering the event observations depicted in Figure 5, we now see how these observations can be used to develop meaningful cause-effect relationships and story lines. Shown in Figure 6 are the results of incorporating these observations into the emerging model of the insurgency campaign. Although each event could potentially impact (provide support for or against) every system influence pathway, we show only the primary connects in this diagram. The numbers correspond to analyst estimates of the evidentiary support (expressed as an evidence ratio) an event reflects for the various influence pathways. They are used in the following Bayesian equation to adjust the evidentiary strength (probability) for each system influence pathway:

$$ES_{POSTERIOR} = \frac{ES_{PRIOR} \times \text{RATIO}_{EVIDENCE}}{(ES_{PRIOR} \times \text{RATIO}_{EVIDENCE}) + 1 - ES_{PRIOR}}$$

where ES_{PRIOR} represents the existing strength of belief that the insurgency is actively emphasizing a specific pathway of influence, and $ES_{POSTERIOR}$ indicates the level of belief after considering the newly added observation. A large positive value for $\text{RATIO}_{EVIDENCE}$ indicates strong support, a zero value indicates neutral support, and a large negative value indicates strong contradictory evidence. Thus, as time goes on, the accumulation of event observations either add support to or detract support from each of the system influence pathways. In this manner, the

analyst is able to maintain an on-going assessment of the evolving emphasis and importance given by the insurgency campaign to each of its lines of operation.

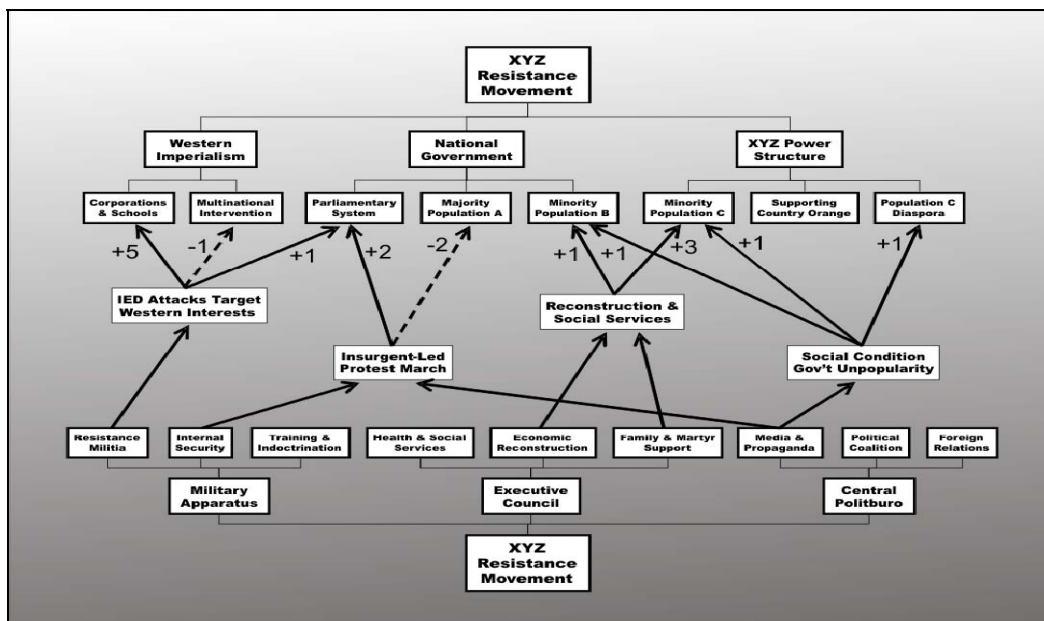


Figure 6 Fictional Insurgency Campaign: Evidentiary Support for Work Control Structure

As seen from Figure 6, a stream of events can reflect a complex set of influences within the multiple influence pathways being pursued by a modern insurgency movement. Additional analytical functionalities within the prototype tool suite provide the analyst with the capability to identify the emergence of new influence pathways and new work system capabilities. Thus, over time, the analyst is able to maintain a working model of an insurgency campaign—one that evolves as the insurgency movement adjusts its operations to overcome various obstacles and to exploit new opportunities as they arise. From this model, the analyst can develop assessments of campaign progress that can be used by effects-based operational planners to guide their development of diplomacy, information, military, and economic initiatives in response to the insurgency campaign.

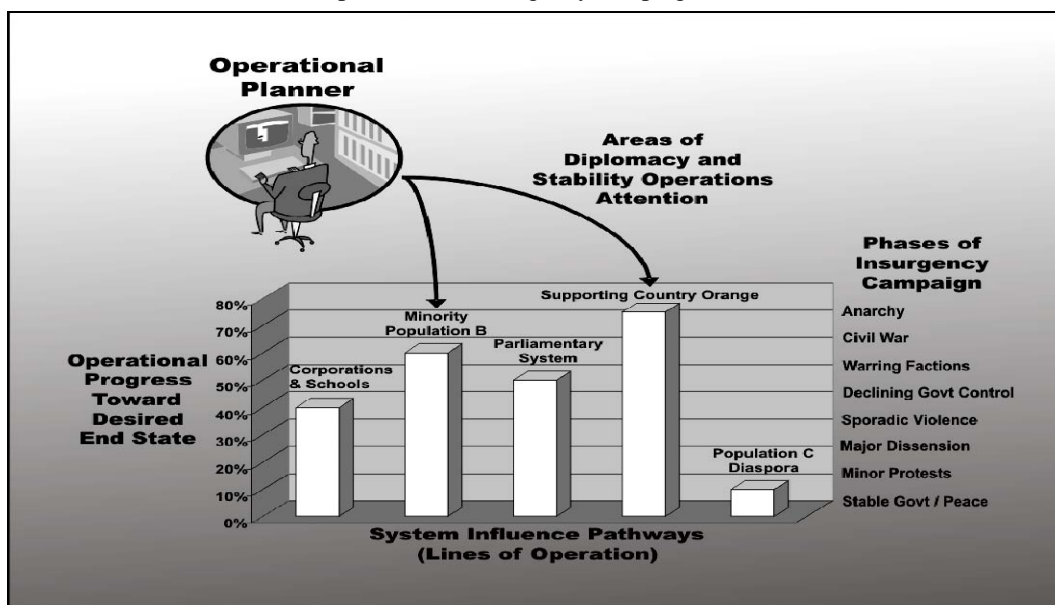


Figure 7 Fictional Insurgency Campaign: Assessment of Relative Progress

Summary

The prototype campaign analysis tool offers three distinct advantages over existing methods of intelligence analysis. These advantages are briefly summarized as follows:

- *Holistic Framework* By placing the analytical process within the context of an insurgency movement's work control structure and lines of operation, the prototype tool enables one to interpret the meaning and significance of individual objects, events, and conditions within a holistic framework. Rather than attempting to build situation awareness and understanding from purely a "bottom-up" perspective, the tool allows the intelligence analyst to anticipate the types of intelligence information likely to be required historically by insurgency movements. Since the tool is solidly grounded in current socio-cognitive theory, it enables the analyst to "see" an insurgency movement from the viewpoint of how a loosely networked and emergent type of organization transforms intent into action through various levels of knowledge creation. The holistic perspective reflected in the analytic framework serves to efficiently guide the evidence management process toward the development of actionable targeting information.
- *Dynamic Story Lines* The prototype campaign analysis tool provides the systems effects analyst with the capability to define story lines within this holistic understanding in an autopoietic manner. Thus, objects, events, and conditions relevant to predictive awareness and understanding are not required to have fixed, universal semantic properties—a shortcoming of current semantic web approaches. Rather, the meaning of a specific knowledge construct and its relationship to other constructs is dynamically determined by its placement within the overall framework of understanding. On the other hand, the proposed tool avoids the pitfalls of allowing a completely open-ended epistemology by providing the analyst with a common framework for modeling the sensemaking structure of an organization operating in a complex environment.
- *Operations-Based Intelligence Analysis* The prototype campaign analysis tool provides a common knowledge framework for supporting collaboration among three key roles within the Joint military commander's planning process: the tactical intelligence analyst, the systems effects analyst, and the operational planner. By "reverse engineering" the process of building an effective insurgency campaign, the tool serves as an effective boundary object linking three communities of analysis. First, the tactical intelligence analyst can employ the tool to guide the process of evidence management. Second, the systems effects analyst can employ the tool to develop the referent linkages required for understanding the causal mechanisms and influence pathways inherent in a specific insurgency campaign. Third, the operational planner can employ the tool to assess the state of progress of an insurgency campaign and to identify key points of disruption.



Work-Centered Approach to Insurgency Campaign Analysis

Paper I-029

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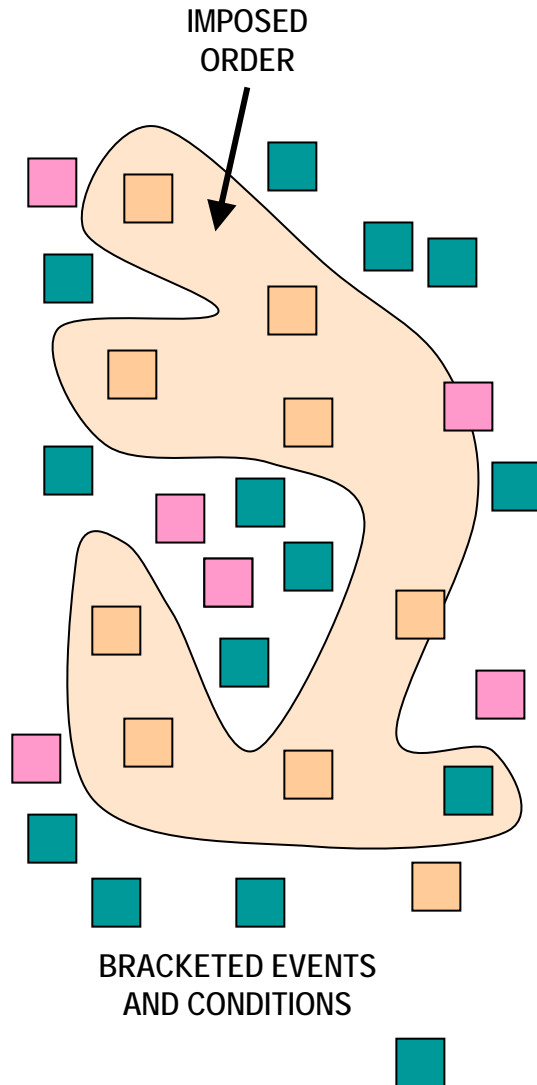
Robert G. Eggleston, Ph.D.

Air Force Research Laboratory, AFRL/HEC



Analysts' Needs and Analytic Strategy

2



Two basic needs of the analysts:

- Reduce disorder (ambiguity and equivocality) to provide a coherent explanation of a complex and evolving situation
- Instantiate beliefs to a workable level of certainty

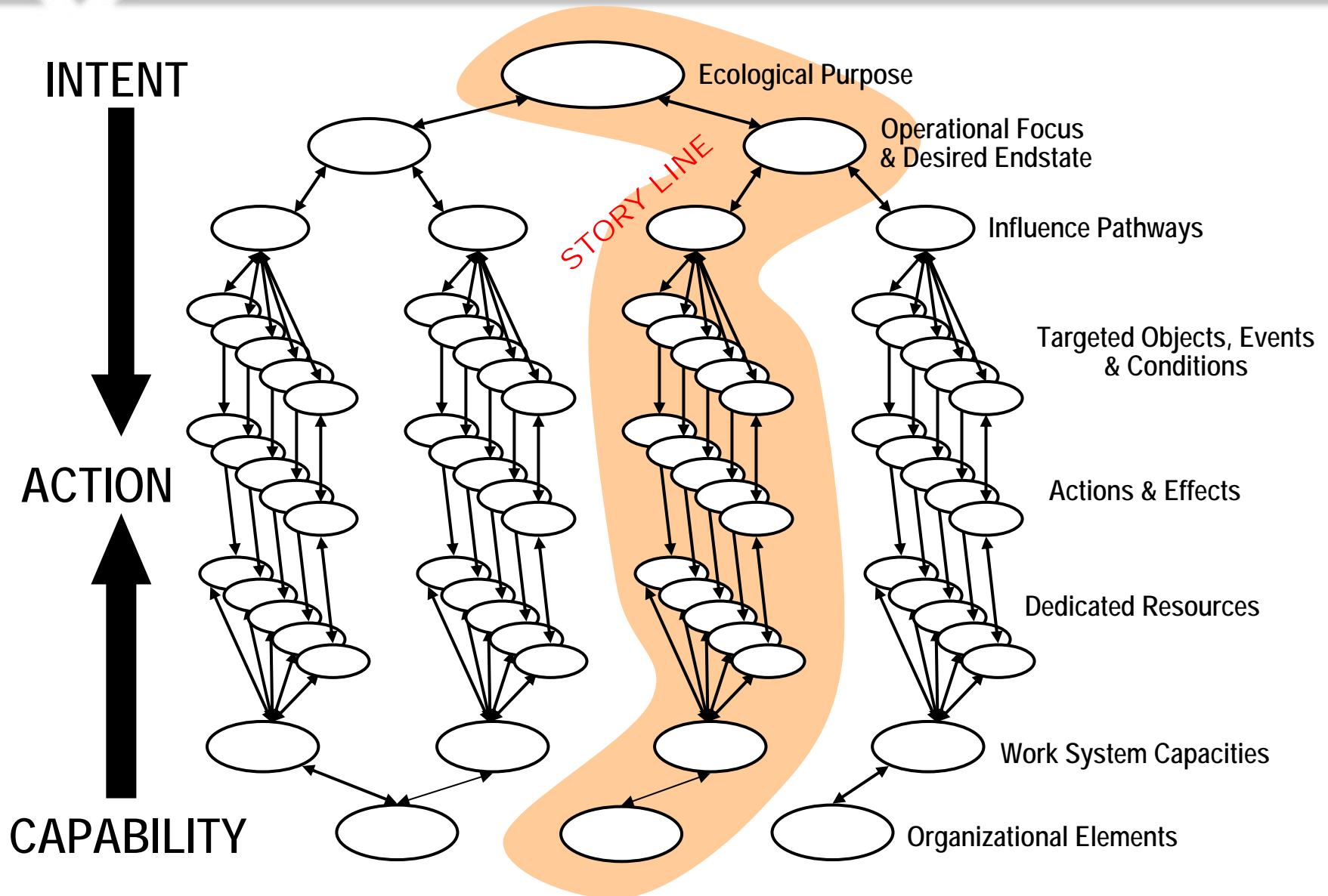
Analytic strategy:

- Incrementally build understanding in a “top down” and “bottom up” manner simultaneously, so as to construct and maintain a feasible story regarding an insurgency campaign's lines of operation and tactical actions
- Stories are epistemologically framed by a work control structure that coherently connects an insurgency's intent with its capabilities and provides a cause/effect context for explaining observed and predicted events and conditions
- Incorporate multiple perspectives, so as to appreciate the breadth and complexity of the operational and tactical problem space impacted by the insurgency campaign
- Construct situational meaning of observed events and conditions as a function of their negotiated placement within an overall story –i.e., understanding is autopoietic in nature
- Treat beliefs as nonpersistent, situation-dependent propositions, not static, universal truths –i.e., beliefs will change in relation to the emergent and opportunistic strategies and tactics of the insurgency movement



Epistemological Structure

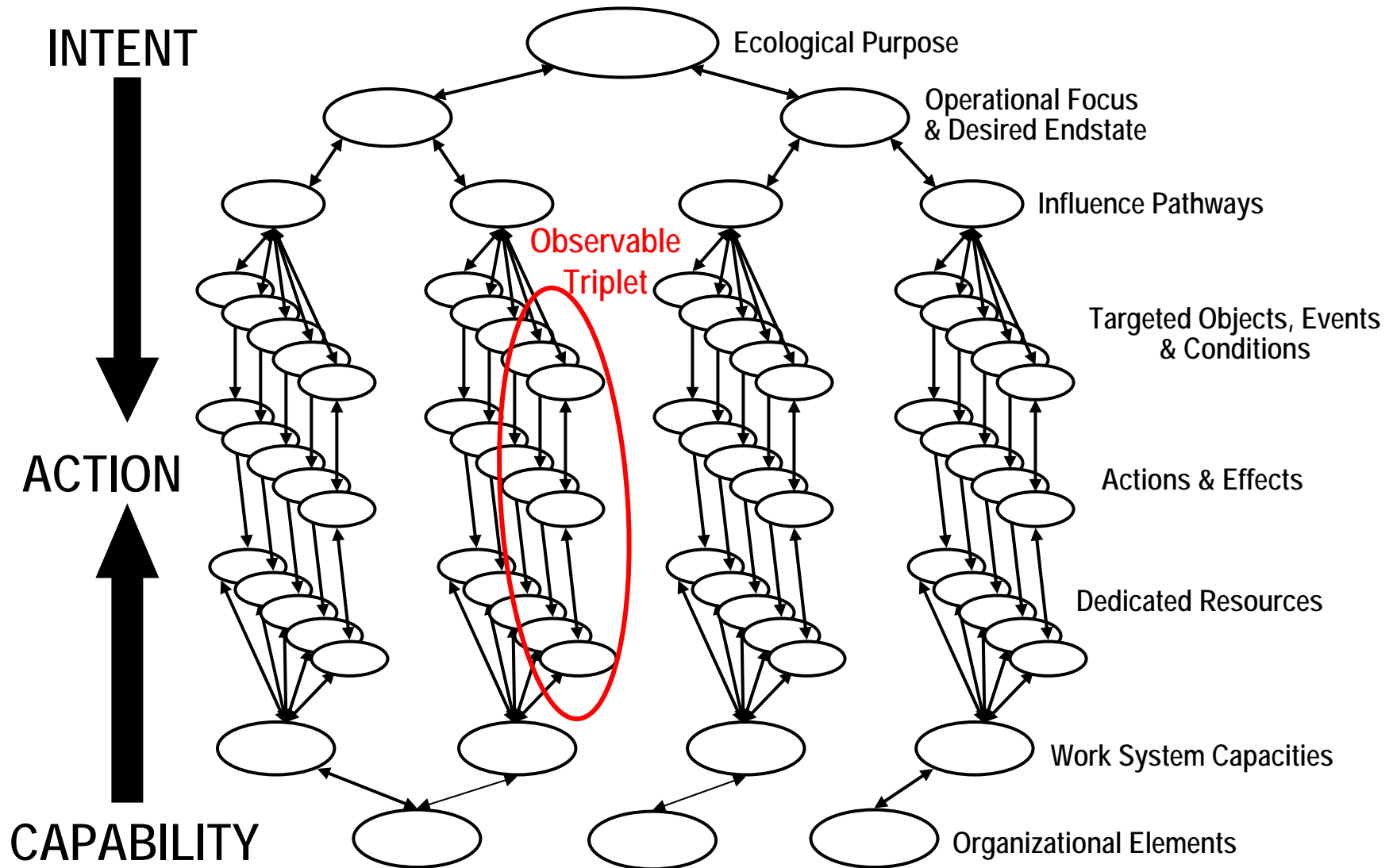
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Constructed Story Lines

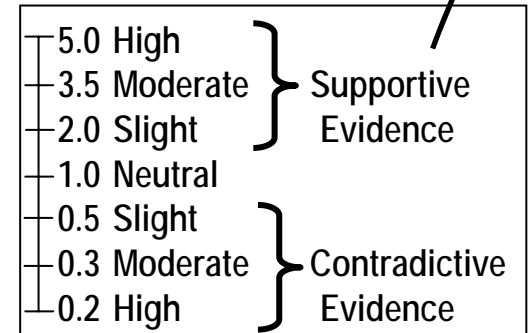
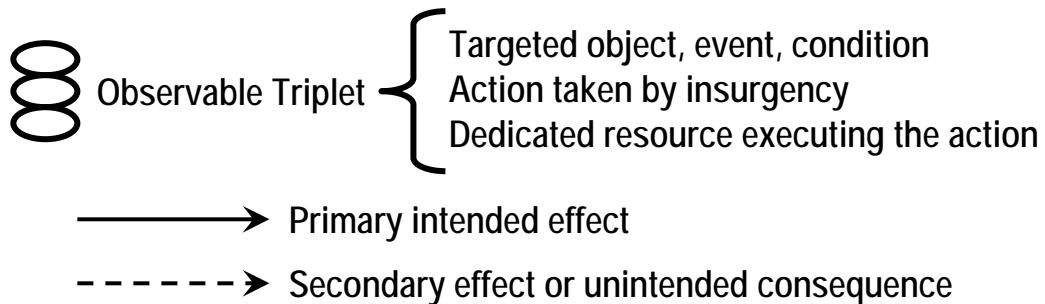
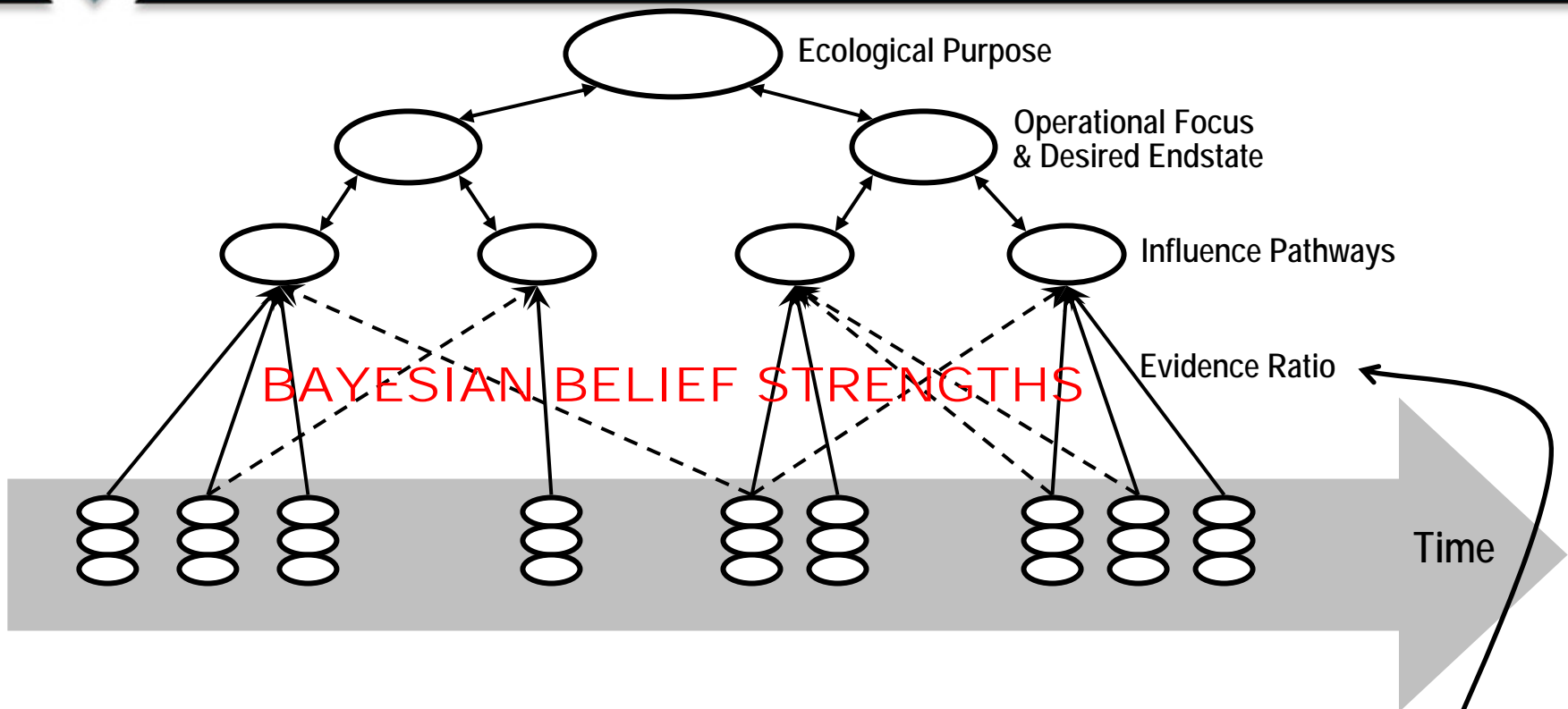
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Hypothesis Instantiation

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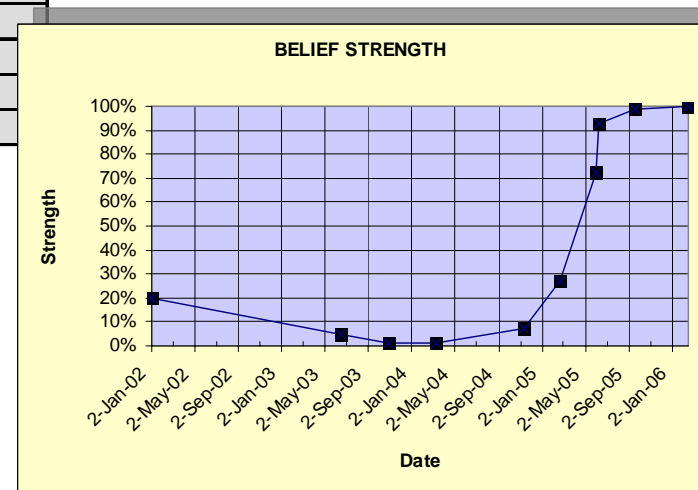


Dynamic Evidence Strengths

6

Bayesian analysis maintains evidentiary strength of each influence pathway based on stream of supportive and contradictory evidence

Item	Evidence Ratio	Date	Current Likelihood
		2-Jan-02	20.0%
1	0.2	15-Jun-03	4.8%
2	0.3	25-Oct-03	1.5%
3	1	8-Mar-04	1.5%
4	5	10-Nov-04	7.0%
5	5	20-Feb-05	27.3%
6	7	30-May-05	72.4%
7	5	10-Jun-05	92.9%
8	6	18-Sep-05	98.7%
9	6	14-Feb-06	99.8%

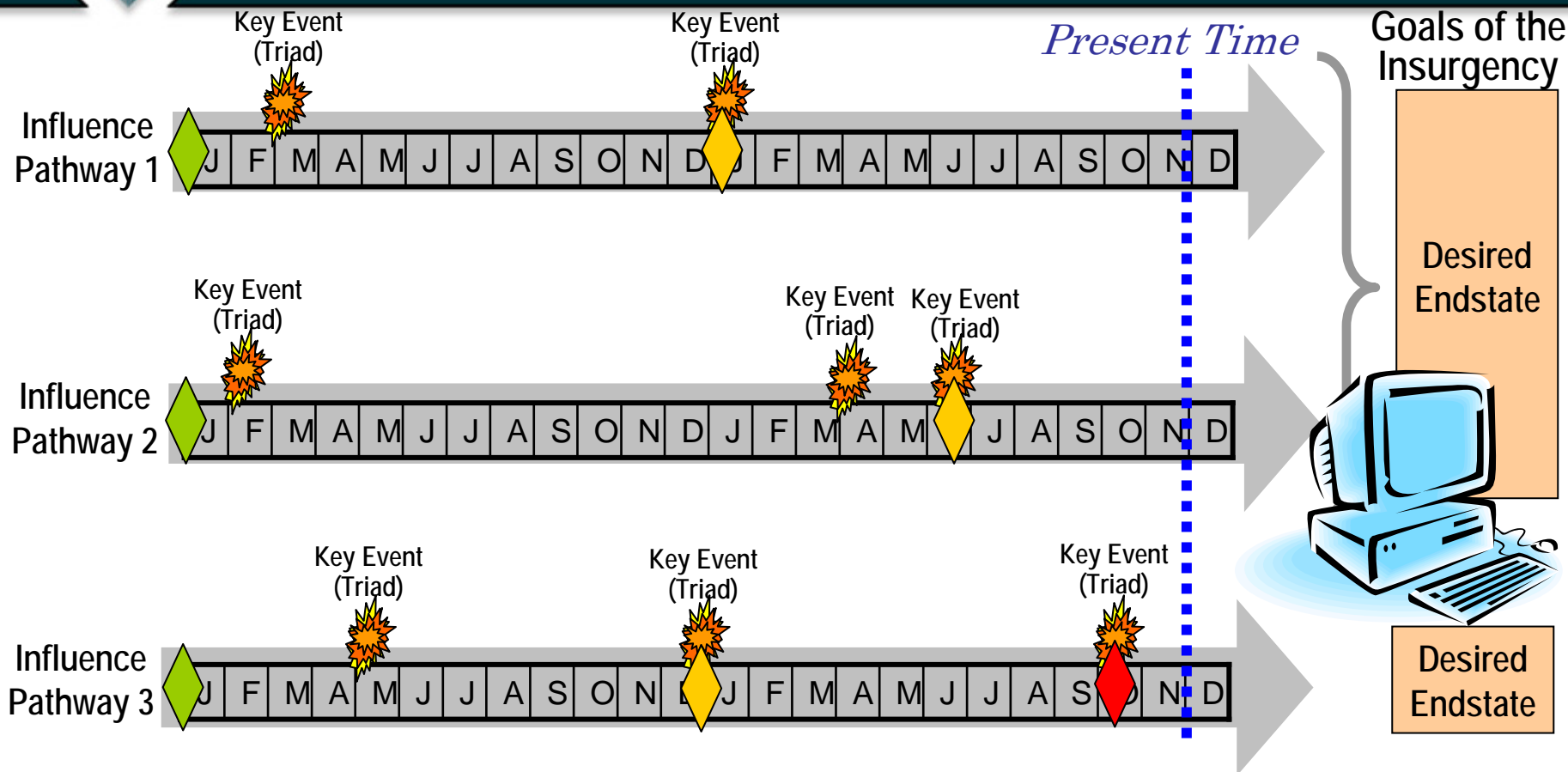


$$ES_{posterior} = \frac{ES_{prior} \cdot RATIO_{evidence}}{(ES_{prior} \cdot RATIO_{evidence}) + 1 - ES_{prior}}$$



Assessment of Campaign Progress

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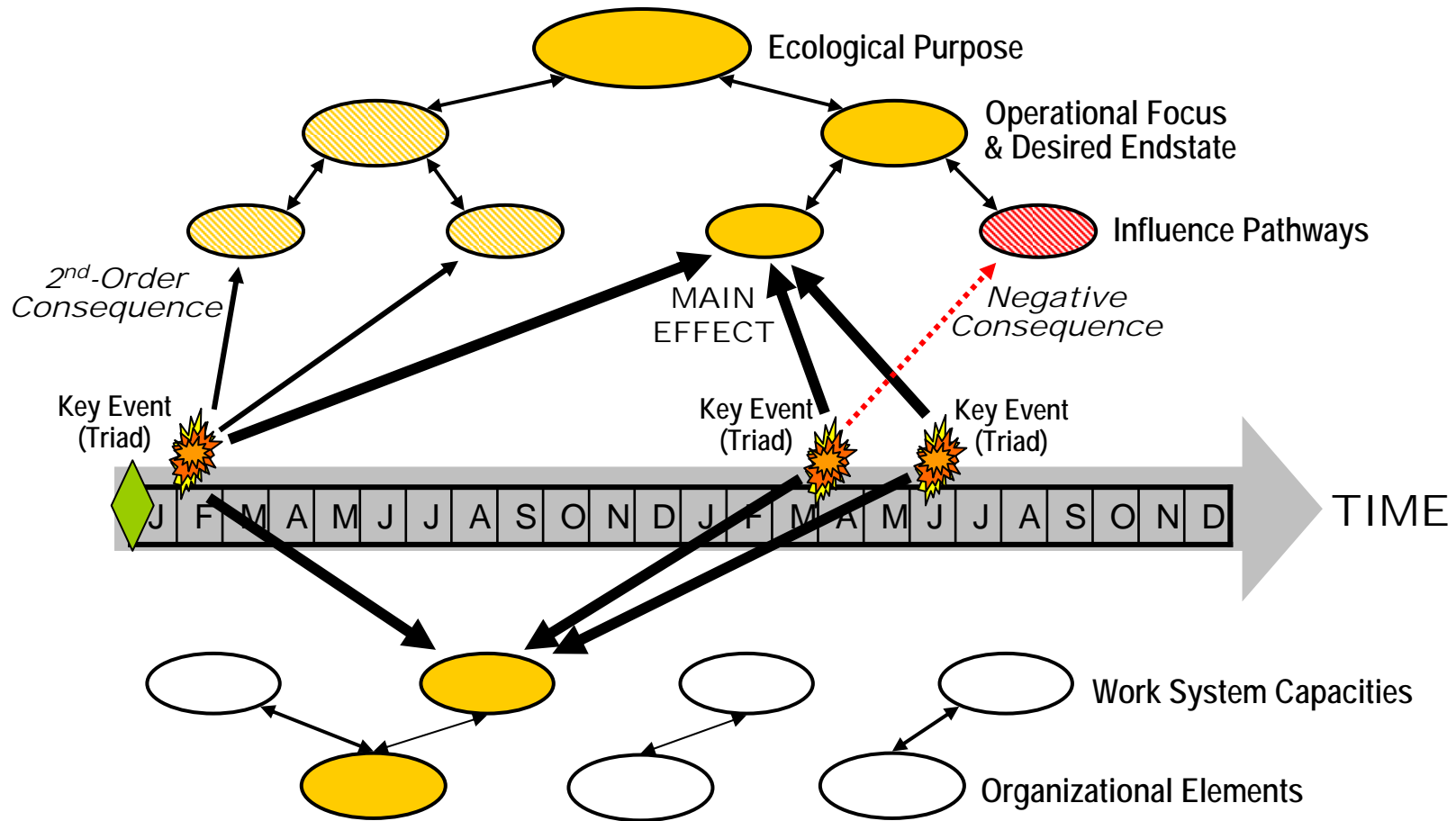
Story lines are constructed around hypothesized lines of operation. Triads are graphically displayed along a temporal scale and compared with key progress milestones to define the history and current state of the insurgency campaign.

Milestone	
	Non-threatening
	Significant Progress
	Critical Point



Neural Network Influences

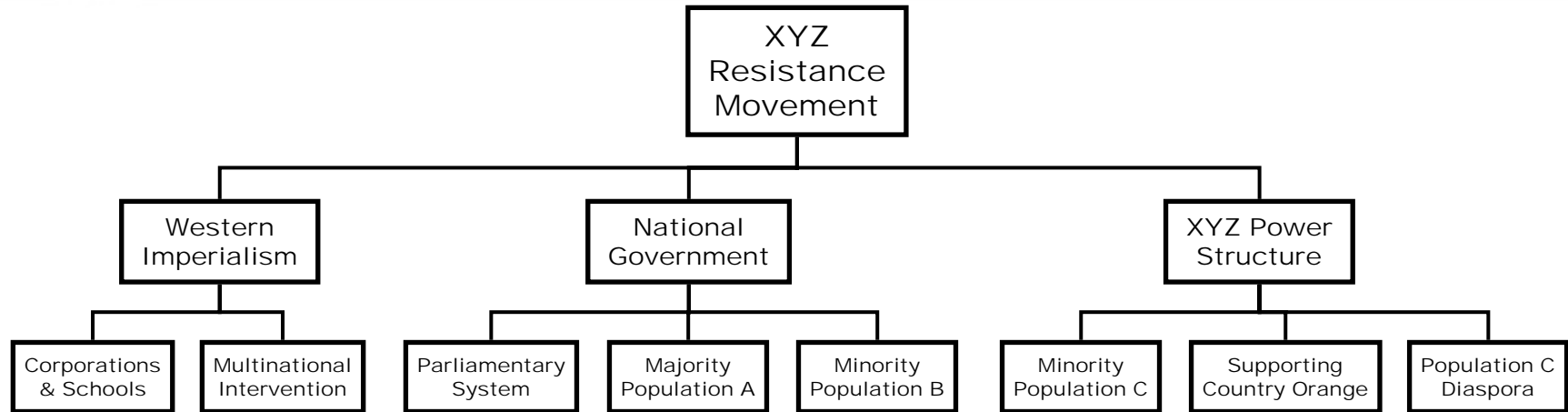
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Fictitious Case Study – Network of Hypotheses

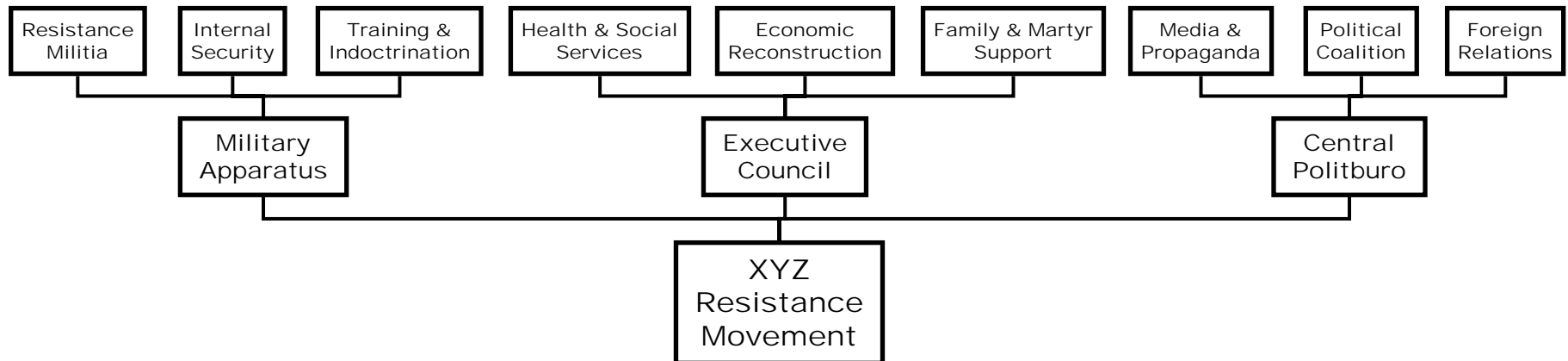
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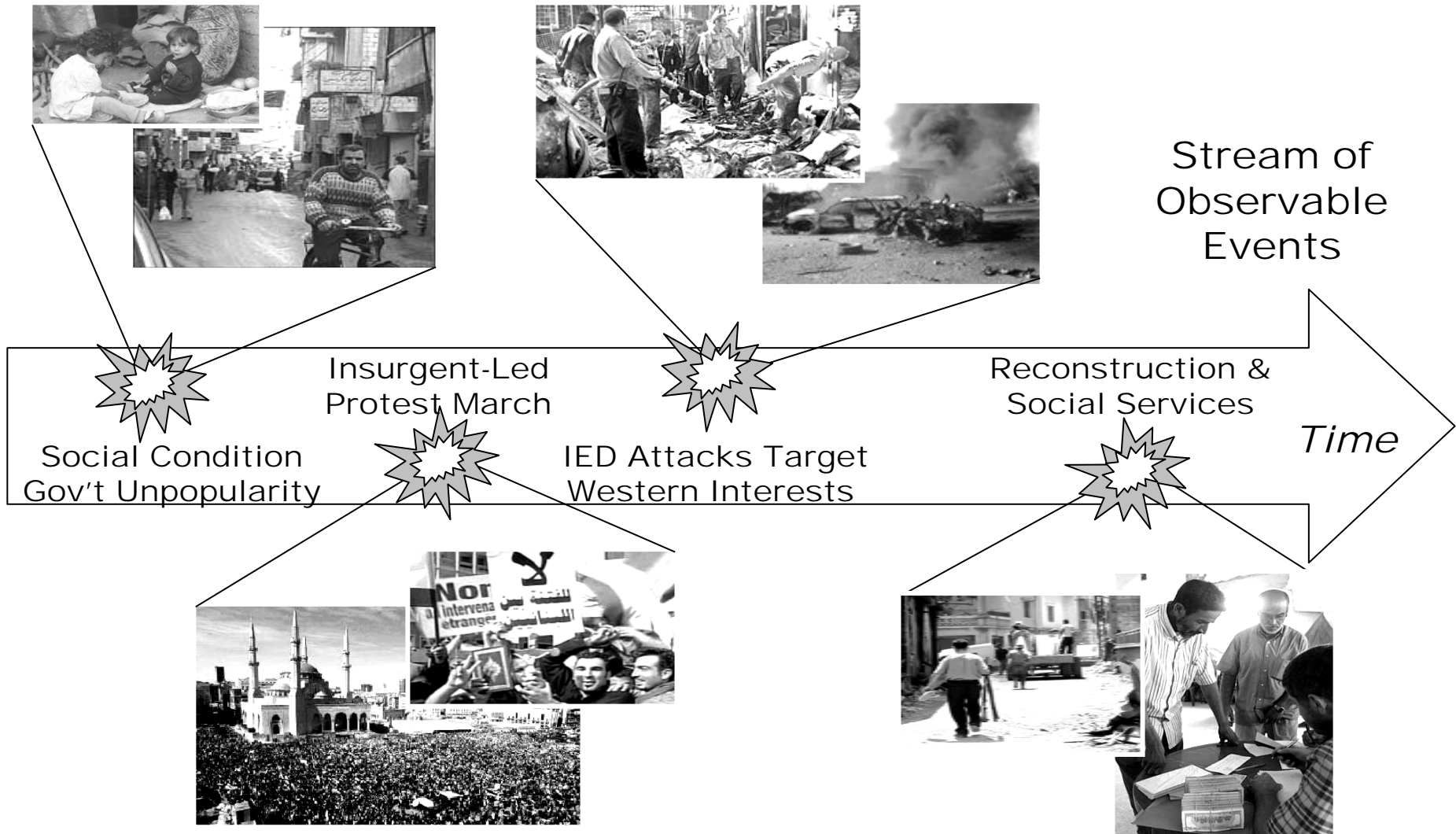


Operational Focus & System Influence Pathways

Cause/Effect Connections ?

Organizational Work System Capabilities

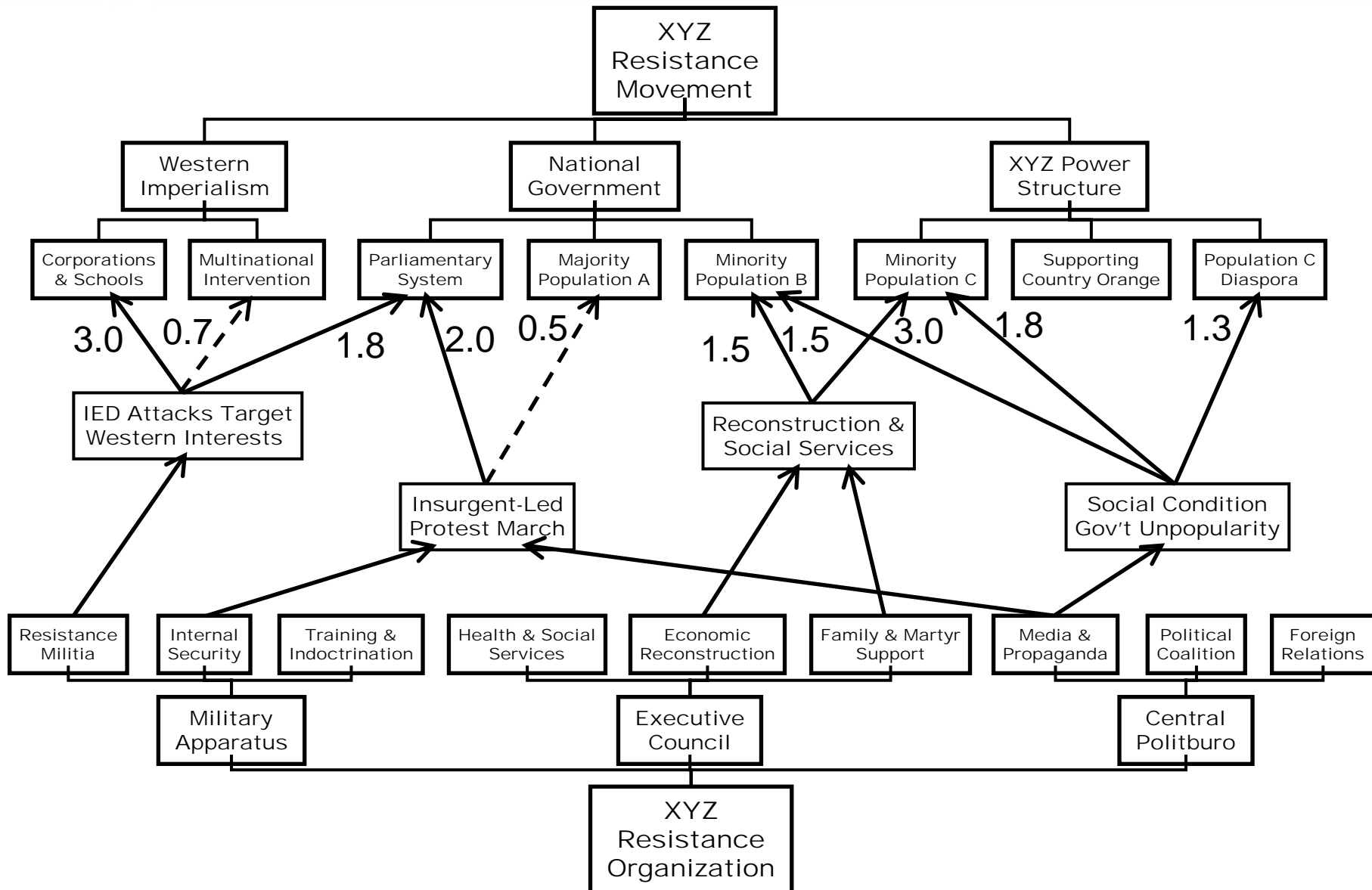






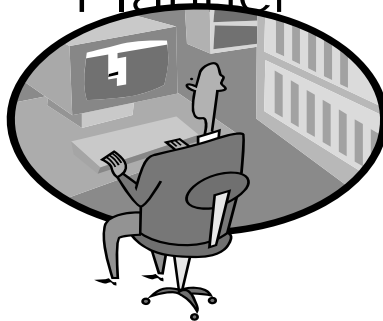
Fictitious Case Study – Evidence Ratios

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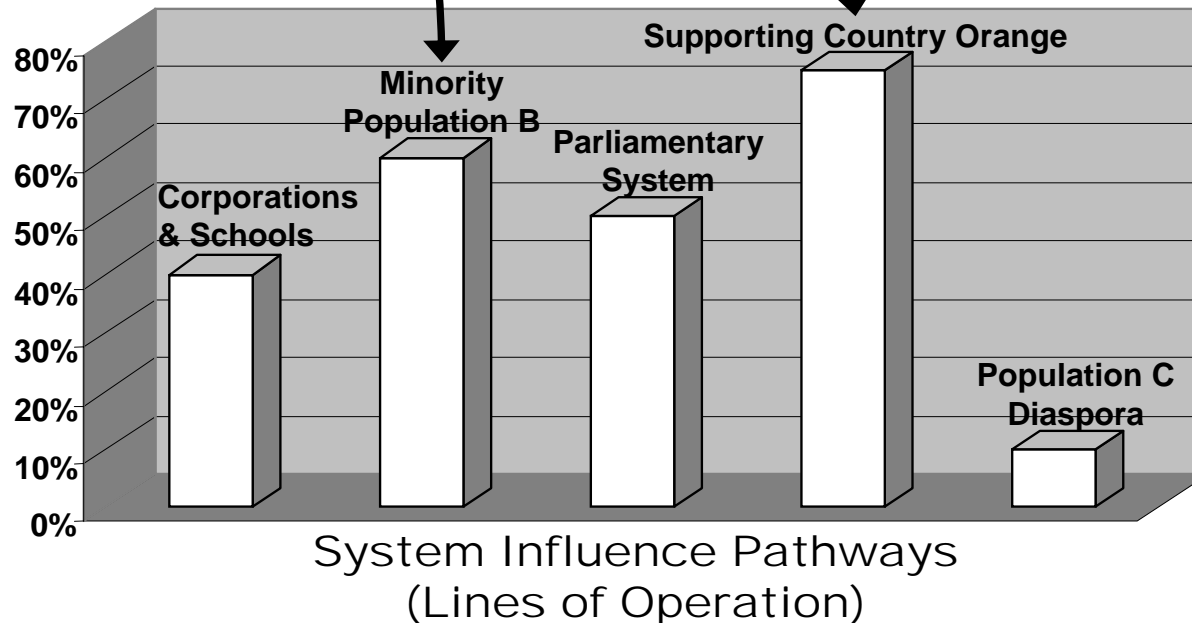


Operational
Planner



Areas of
Diplomacy and
Stability Operations
Attention

Operational
Progress
Toward
Desired
End State



Phases of
Insurgency
Campaign

Anarchy
Civil War
Warring Factions
Declining Govt Control
Sporadic Violence
Major Dissension
Minor Protests
Stable Govt / Peace